# Configuration Management

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Lecture is every week Wednesday 09:00 - 11:00.

| | |
|---|---|
| 06.03.2019: | topic, teams |
| 13.03.2019: | TISS registration, initial PR |
| 20.03.2019: | other registrations, guest lecture |
| 27.03.2019: | PR for first issue done, second started |
| 03.04.2019: | first issue done, PR for second |
| 10.04.2019: | mid-term submission of exercises |
| 08.05.2019: | different location: Complang Libary |
| 15.05.2019: | |
| 22.05.2019: | all 5 issues done |
| 29.05.2019: | |
| 05.06.2019: | final submission of exercises |
| 12.06.2019: | |
| 19.06.2019: | last corrections of exercises and register for exam |
| 26.06.2019: | exam |

## Tasks for today

(until 05.06.2019 23:59)

**Task**

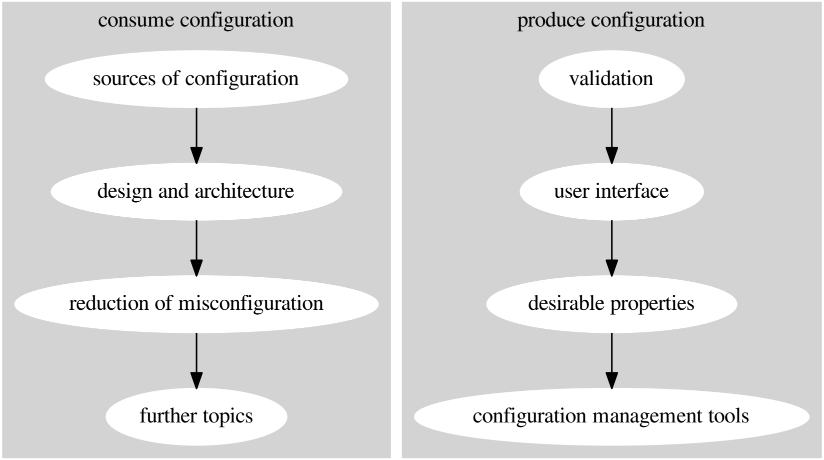
Submit teamwork and homework.

Please also

- register for the exam in TISS.
- push your slides from the talk in the cm2019s repo.

## Popular Topics

| | | | |
|---|---|---|---|
| 14 | tools | 4 | design |
| 9 | testability | 4 | cascading |
| 9 | code-generation | 4 | architecture of access |
| 7 | context-awareness | 3 | configuration sources |
| 6 | specification | 3 | config-less systems |
| 6 | misconfiguration | 2 | secure conf |
| 6 | complexity reduction | 2 | architectural decisions |
| 5 | validation | 1 | push vs. pull |
| 5 | points in time | 1 | infrastructure as code |
| 5 | error messages | 1 | full vs. partial |
| 5 | auto-detection | 1 | convention over conf |
| 4 | user interface | 1 | CI/CD |
| 4 | introspection | 0 | documentation |


consume configuration
sources of configuration
design and architecture
reduction of misconfiguration
further topics
produce configuration
validation
user interface
desirable properties
configuration management tools

## Recapitulation

## Early detection (Recapitulation)

**Task**

When do we want to detect misconfiguration?

Phases when we can detect misconfigurations:

- Compilation stage in configuration management tool
- Writing configuration settings on nodes
- Starting applications (load-time)
- When configuration setting is actually used (run-time)

**Problem**

Earlier versus more context.

## Contextual Values (Recapitulation)

**Task**

What are contextual values?

Tanter [7] introduced a lightweight extension to context-oriented programming: ***Contextual values*** are variables whose values depend on the context in which they are read and modified. They *"boil down to a trivial generalization of the idea of thread-local values"*. The key idea is to use layers as *"discriminate amongst possible values, not only the current thread"* [7]. Side effects are limited to the respective context [4].

## Definition Context (Recapitulation)

**Task**

What is context-aware configuration?

As adapted from Chalmers [1]:

> ***Context*** *is the circumstances relevant to the configuration settings of the application.*

We extend the definition with:

> ***Context-aware configurations*** *are configuration settings that are consistent with its context.* ***Context-aware configuration access*** *is configuration access providing context-aware configuration.*

## Elektra (Recapitulation)

- is not only a key database but a specification language to describe a key database
- plugins implement the specification (could be distributed but focus is configuration files)
- is library based (no single point of failure, no distributed coordination needed)
- supports transactions (persisting whole KeySets at once)
- supports integration of existing configuration settings

## Definition Configuration Management (Recapitulation)

- is a discipline in which configuration (in the broader sense) is administered.
- makes sure computers are assembled from desired parts and the correct applications are installed.
- has means to describe the desired configuration of the whole managed system.
- ensures that the execution environment of installed applications is as required.

## Possible Benefits of CM (Recapitulation)

- All advantages scripts have:
  Documentation, Customization, Reproducability
- Declarative description of the system
  (Infrastructure as Code [2])
- Auditability
- Less configuration drift
- Error handling
- Pull/Push
- Reusability
- (Resource) Abstractions

## Learning Outcomes

Students will be able to

- define terms of properties of CM.
- analyze validation specifications.
- remember the difference between checking the specifications vs. checking the settings.

## Terms and Properties

## Infrastructure as Code

Once we described configuration settings, configuration settings are simply an instantiation of the configuration specifications.

Code describing the instantiation is **CM code**.

**Auditability:** Being informed about status and changes in the infrastructure.

**Goal**

Single Source of Truth

## Configuration Drift

Are derivations of the “Single Source of Truth” (the CM code).
Caused by:

- manual configuration changes by administrators
- manual configuration changes by end users
- differences in updates (e.g., skipped or failed updates)
- failed attempts to change configuration
- applying different versions of CM code
- ...

## Push vs. Pull

- Push is more interactive.
- Push cannot do its job if nodes are not reachable.
- Push needs additional techniques to scale with many nodes.
- Push demands access to servers from a single server.
- Pull needs additional monitoring to know when a patch has been applied.
- Pull needs resources even if nothing is to do.

**Task**

Do you prefer push or pull? What does your CM tool of choice use?

## Idempotence

idem + potence (same + power)

Yield same result with any number of applications ($n \geq 1$):

$$f(f(x)) = f(x)$$

Siméon and Wadler [6] describe two further properties:

Self-describing means that from the configuration file alone we are able to derive the correct data structure [6].

Round-tripping means that if a data structure is serialized and then parsed again, we end up with an identical data structure [6].

The data structure could be a KeySet.

Round-tripping is a prerequisite of idempotence.

**Task**

Explain the three concepts your neighbor (idempotence, self-describing, round-tripping).

## Validation

## Checking Configurations

Following properties of configuration settings can be checked:

- values (data types)
- structure
- constraints
- semantic checks (e.g., IP, folder)
- domain-specific checks (e.g., databases)
- requirements (suitable configurations)
- context (context-aware configurations)

Elektra supports many other data types, each implemented in its own plugin(s):

| | |
|---|---|
| check/type | allows us to specify CORBA data types. Checking "any" (default) is always successful. The record and enum types defined by CORBA are not part of this plugin but of others as explained below. |
| check/enum | supports a list of supported values denoted by array indexes. |
| check/bool | transforms specific strings, for example "true" and "false", into the canonical boolean representation, i. e., "0" and "1". |
| check/ipaddr | checks if a string is a valid IP address. |
| check/path | checks presence, permissions, and type of paths in the file system. |

| | |
|---|---|
| check/date | supports to check date formats such as POSIX, ISO8601, and RFC2822. |
| check/validation | checks the configuration value with regular expressions. |
| check/condition | checks using conditionals and comparisons. |
| check/math | checks using mathematical expressions. |
| check/range | allows us to check if numerical values are within a range. |
| trigger/error | allows us to express unconditional failures. |
| check/rgbcolor | allows us to check for RGB colors, by Philipp Gackstatter. |
| check/macaddr | (will allow us to check for MAC addresses, by Thomas Bretterbauer) |

## Checking Specifications

The goals of checking SpecElektra are:

- Defaults must be present for safe lookups. This goal also implies that there must be at least one valid configuration setting.
- Types of default values must be compatible with the types of the keys.
- Every contextual interpretation of a key must yield a compatible type.
- Links must not refer to each other in cycles.
- Every link and the pointee must have compatible types.

## Example

```
[sw/org/abc/has_true_arg]
  type:=boolean
  default:=0
  override/#0:=/sw/org/abc/arg0
  override/#1:=/sw/org/abc/arg1
```

## Logfile Example

```
[slapd/logfile]
  check/path:=file
```

## Logfile Extensions

```
[slapd/logfile]
  check/path:=file
  check/validation:=^/var/log/
  check/validation/message:=Policy violation:
    log files must be below /var/log
```

## Error Messages

Error messages are extremely important as they are the main communication channel to system administrators.
Example specification:

```
[a]
  check/type:=long
[b]
  check/type:=long
[c]
  check/range:=0-10
  assign/math:=../a+../b
```

## Error Messages

Problems:

- Generic vs. specific plugins
- General principles of good error messages [3]
- Give context
- Precisely locate the cause:

```
a=5   ; unmodified
b=10  ; modification bit in metadata
      ; is only set here
c=15  ; unmodified by user but changed
      ; later by assign/math
```

## Example Error Message

```
Sorry, I was unable to change the configuration settings!
Description: I tried to set a value outside the range!
Reason: I tried to modify b to be 10 but this caused c to
        be outside of the allowed range (0-10).
Module: range
At: sourcefile.c:1234
Mountpoint: /test
Configfile: /etc/testfile.conf
```

## Conclusion

- Definition and challenges in configuration management.
- Properties: self-describing, idempotent, round-tripping.
- Validation is combined effort of devs and admins.

## Outlook

- Error Messages
- Configuration Management Tools and Languages
- User Interface: View of Administrators

[1] Daniel Chalmers. *Contextual mediation to support ubiquitous computing*. PhD thesis, University of London, 2002.

[2] Waldemar Hummer, Florian Rosenberg, Fábio Oliveira, and Tamar Eilam. Testing idempotence for infrastructure as code. In David Eyers and Karsten Schwan, editors, *Middleware 2013*, pages 368–388, Berlin, Heidelberg, 2013. Springer Berlin Heidelberg. ISBN 978-3-642-45065-5.

[3] Michael J. Lee and Andrew J. Ko. Personifying programming tool feedback improves novice programmers' learning. In *Proceedings of the Seventh International Workshop on Computing Education Research*, ICER '11, pages 109–116, New York, NY, USA, 2011. ACM. ISBN 978-1-4503-0829-8. doi: 10.1145/2016911.2016934. URL `http://dx.doi.org/10.1145/2016911.2016934`.

[4] Markus Raab. Unanticipated context awareness for software configuration access using the getenv API. In *Computer and Information Science*, pages 41–57. Springer International Publishing, Cham, 2016. ISBN 978-3-319-40171-3. doi: 10.1007/978-3-319-40171-3_4. URL http://dx.doi.org/10.1007/978-3-319-40171-3_4.

[5] Markus Raab and Gergö Barany. Introducing context awareness in unmodified, context-unaware software. In *Proceedings of the 12th International Conference on Evaluation of Novel Approaches to Software Engineering - Volume 1: ENASE,*, pages 218–225. INSTICC, SciteПress, 2017. ISBN 978-989-758-250-9. doi: 10.5220/0006326602180225.

[6] Jérôme Siméon and Philip Wadler. The essence of xml. pages 1–13, 2003. doi: 10.1145/604131.604132. URL http://dx.doi.org/10.1145/604131.604132.

[7] Éric Tanter. Contextual values. In *Proceedings of the 2008 Symposium on Dynamic Languages*, DLS '08, pages 3:1–3:10, New York, NY, USA, 2008. ACM. ISBN 978-1-60558-270-2. doi: 10.1145/1408681.1408684. URL `http://dx.doi.org/10.1145/1408681.1408684`.